FY03 Technical Program Summary

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Vehicle Technology Directorate - Glenn Site
US Army Research Laboratory
at
NASA Glenn Research Center
Cleveland, OH 44135-3191

The ARL Vehicle Technology Directorate at the Glenn Research Center conducts research in two business areas:

Engine Technologies and
Power Transmission

Program areas funded under these technical competencies include basic (6.1) and applied (6.2) research in Aviation Technology and Ground Vehicle Technology. The following "Table of Contents" outlines the organization of the work packages and individual research projects within this document.

Aerodynamic Components Research - 6.1 - 61102 / AF20 / VP1A11F

VP1A11F.0161-01	Compressors - Ultra Efficient Engine Technology (UEET)
VP1A11F.0161-02	Centrifugal Compressor Flow Physics
VP1A11F.0161-03	Wave Rotor Development
VP1A11F.0161-04	Flow Control Technology
VP1A11F.0161-05	Engine Simulations - High Fidelity Multidisciplinary Simulations
VP1A11F.0161-14	Structures - Fatigue of Metallic Materials
VP1A11F.0161-15	Materials - Improved PMR Solution and PMR Prepreg Stability
VP1A11F.0161-16	Materials - Silicon Based CMC for Turbine Components
VP1A11F.0161-17	Materials - Numerical Modeling of Oxidation Kinetics of CMCs
VP1A11F.0161-18	Materials - Thermal Gradient / Stress Testing
VP1A11F.0161-19	Controls - Autonomous Robotic Controls Technology
VP1A11F.0161-20	Materials - Advanced 3000F Coating Concept
VP1A11F.0161-21	Controls - Autonomous Propulsion System
VP1A11F.0161-22	Controls - Model Based Controls and Diagnostics
VP1A11F.0161-23	Materials - Improved Oxidation Resistance of CMCs

Mechanical Components Research - 6.1 - 61102 / AF20 / VP1A13F

VP1A13F.0161-07	Mechanical Components - Low Noise Transmissions
VP1A13F.0161-09	Mechanical Components - Damage Assessment
VP1A13F.0161-10	Mechanical Components - Gear Tooth Crack Propagation Studies

Internal Combustion Engine Research - 6.1 - 61102 / AF20 / VP1T14F

VP1T14F.0161-12	Mechanical Components - Advanced Journal Bearing Analyses
VP1T14F.0161-13	Mechanical Components - Oil-Free Foil Bearing Technology

STO - Integrated High Perf. Turbine Engine Tech. IHPTET III - 6.2 - 62211 / A47B / VP2A15B

VP2A15B.0162-01	Advanced Centrifugal Compressor
VP2A15B.0162-02	Computational Grid Environment for 3D Propulsion Simulations
VP2A15B.0162-03	Combustors - Ceramic Matrix Composite Component - Rig Demonstration
VP2A15B.0162-04	Turbines - Monolithic Ceramic and Ceramic Matrix Composite (CMC) Turbine Nozzle
VP2A15B.0162-05	Mechanical Components - Seals Research
VP2A15B.0162-06	Mechanical Components - Magnetic Bearing Technology
VP2A15B.0162-11	Active Stall Control Development
VP2A15B.0162-12	Materials - Low Conductivity Thermal Barrier Coating Development

R/C Drive Systems/21st Century (RDS21) - 6.2 - 62211 / A47B / VP2A15D

VP2A15D.0162-08	Rotorcraft Drives - High Power Density Drive Systems
VP2A15D.0162-09	Rotorcraft Drives - Face Gear Development
VP2A15D.0162-10	Rotorcraft Drives - High Speed Helical Gear Thermal Behavior

Durable Affordable Engine Component Technology - 6.2 - 62211 / A47B / VP2A15E

VP2A15E.0162-07	Mechanical Components - Oil-Free Turbomachinery

Date Last Modified: 15-JAN-03

BUSINESS SUBAREA: 6.1 Basic Research

PE/PRJ/WP#/WP: 61102 AF20 VP1A11F Aerodynamic Components Research

DIRECTORATE/DIVISION VEHICLE TECHNOLOGY Engine Components Division (ECD)

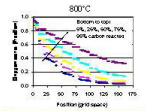
POC/PHONE: Waldo Acosta 216-433-3393

THRUST:

Establish a basic understanding of new, advanced aerodynamic engine component concepts and high temperature materials and structures to enable substantial increases in efficiency, power density, and affordability of gas turbine engines. Advance their technology readiness level sufficiently to pursue them in applied research projects.

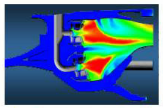
OBJECTIVES:

Provide advanced engine component technology, high temperature materials and structural concepts, and physics-based analytical codes to enable a 40% improvement in specific fuel comsumption, double the thrust to weight, and reduce acquisition cost by 35%.

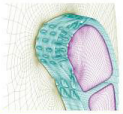


Life prediction methodology


High temperature materials development


Full combustor simulation computational time reduction


High fidelity multidisciplinary algorithms


Evaluation of ultra-effective turbine cooling concepts


Development of turbomachinery flow control concepts

PROGRAM SCHEDULE:

	2002	2003	2004	2005	2006
Compressors - Ultra Efficient Engine Technology (UEET)		▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Centrifugal Compressor Flow Physics	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Wave Rotor Development	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	
Flow Control Technology	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Engine Simulations - High Fidelity Multidisciplinary Simu	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Structures - Fatigue of Metallic Materials	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Materials - Improved PMR Solution and PMR Prepreg St	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Materials - Silicon Based CMC for Turbine Components	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Materials - Numerical Modeling of Oxidation Kinetics of	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Materials - Thermal Gradient / Stress Testing	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Controls - Autonomous Robotic Controls Technology	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Materials - Advanced 3000F Coating Concept	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪

FY03 KEY DELIVERABLES:

- Complete fabrication of casing treatment hardware for testing advanced casing treatment concept and initiate testing.
- Complete micro-transpiration experiments in a centrifugal compressor with a vaneless diffuser.
- Assess impact of micro-porous transpiration on performance and operability of high-speed centrifugal compressor with vaneless diffuser.
- Develop and demonstrate efficacy of directed synthetic jets to manage secondary flow driven aerodynamic blockage in cu
- Determine the extent of life variability due to inclusion size sampling distribution.
- Improve and model thermal conductivity of SiC/SiC composites.
- Determine microstructural stability of CVI and polymer derived SiC/SiC composites.
- Develop 3000F capability, multi-component hafnia- and perovskite-based oxide coating systems for SiC/SiC ceramic matrix composite (CMC) combustor liner applications to improve high temperature stability, cyclic durability, and maintain long-term low thermal conductivity (12/2002);

This chart covers Fiscal Year 2003

Business SUBAREA:	6.1		Basic Research	
PE/PRJ/WP#/WP:	61102	AF20	VP1A11F	Aerodynamic Components Research

Workyears	2002	2003	2004	2005	2006
ARMY	8.7	12.4	11.95	10.95	10.95
NASA	9.45	18.75	15.75	15.75	12.75
OTHER	3	6.5	6.5	6.5	3.5

Basic Research

OBJECTIVE

This research provides advanced component concepts, materials science basis, and flow physics based computational fluid dynamics (CFD) codes to enable a 40% reduction in specific fuel consumption and a 120% increase in turboshaft/turboprop power-to-weight ratio, consistent with the requirements of the DoD Integrated High Performance Turbine Engine Technology Program.

APPROACH

To investigate physical phenomena, experimental data bases, mathematical models, and computer codes that will result in aerodynamic components (compressors, combustors, and turbines) having increased performance,operability and durability, along with smaller size and weight. Advanced component concepts are investigated on a fundamental level in order to provide sufficient understanding of associated physical processes, allowing assessment of developmental readiness. In the material science area, deliverables include processing technology, as well
as data, models, and analytical tools for the prediction of life and damage accumulation in conventional (metallic) and unconventional (ceramic matrix composite (CMC) and polymer) gas turbine engine materials. These technologies are disseminated to all U.S. gas turbine engine manufacturers via technical reports, seminars, and colleagueal interaction with peers in the industry. The described efforts are being performed as joint technical programs between the Army VTD-Glenn site and the NASA Glenn Researc Center. In some cases, programs are conducted in cooperation with industry participation without echanging funds and others are funded by other government agencies.The VTD-Glenn site thus leverages NASA, industry, and other agencies dollars, workforce, and test facilities.

SIGNIFICANCE

This results of this workpackage will provide the basic technologies that will enable the developement of advanced rotorcraft and ground vehicles with improved range/payload and performance attributes. The logistics support burden is reduced through reductions in fuel requirements. The derived technologies are applicable to future systems or fielded/developmental system upgrades.

PROGRAM SCHEDULE:

Compressors - Ultra Efficient Engine Technology (UEET)		▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
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Wave Rotor Development	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	
Flow Control Technology	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Engine Simulations - High Fidelity Multidisciplinary Simu	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Structures - Fatigue of Metallic Materials	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
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Materials - Silicon Based CMC for Turbine Components	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
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Materials - Thermal Gradient / Stress Testing	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Controls - Autonomous Robotic Controls Technology	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Materials - Advanced 3000F Coating Concept	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪

- Develop low stress, strain-tolerant, and chemical compatible interface layers between the high thermal expansion top oxide layer and the low thermal expansion silicate EBC and CMC substrate (03/2003).
- Engine simulation demonstration of intelligent engine control that adapts to slow changes in engine dynamics due to aging and component degradation
- Model engine faults in a simulation environment for follow-on analysis
- Develop damage detection algorithms
- Test and analysis of oxidation resistance in five different C/SiC composite materials (TGA, tensile tests, stress rupture, and microstructural analysis).

This chart covers Fiscal Year 2003